COMMUNICATIONS SYSTEM USING HIERARCHICAL QUEUE STRUCTURE FOR EMAIL MESSAGE DELIVERY AND RELATED METHODS

Field of the Invention

[0001] The present invention relates to the field of communications systems, and, more particularly, to electronic mail (email) systems and related methods.

Background of the Invention

[0002] In an email system, email messages are typically generated by users on communications devices such as personal computers (PCs), personal data assistants (PDAs), etc. Once generated, these messages are forwarded to an email delivery server which hosts the users' email accounts. For example, in a corporate environment, a user's communications device may be connected to an email delivery server via a local area network (LAN), while home users may connect to a delivery server of an Internet service provider (ISP) via a dial-up or broadband communications link.

[0003] The email delivery server temporarily stores the email messages in a queue for processing and sending to the destination message box (or boxes)

associated with the email message. The destination message box is designated by the recipient address the user includes with the email. Presuming that a recipient's message box is not hosted on the email delivery server, the email messages are forwarded via a wide area network (WAN) (e.g., the Internet) to a destination server at which the recipient message box is hosted. The email address associated with the message also designates the appropriate destination server. Once the destination server receives an email message, it stores the email message in the intended recipient's message box.

[0004] Sometimes problems arise during this email delivery process. Perhaps the most frequent of these problems is that a recipient's message box is full, in which case the destination server is unable to store new email messages in the message box. In such case, the destination server will typically generate a fatal error message, which is returned to the email delivery server to indicate that the message has not been delivered. Another potential problem is that the destination server is down or otherwise unavailable. In this case, an intermediate server or routing device will generate a temporary failure message, which is also returned to the email delivery server.

[0005] The email delivery server sends email messages stored in its queue at a predetermined sending rate (every few minutes, etc.). When a large number of mail delivery failures occur, the queue begins to fill up as users continue to generate more and more messages and the undelivered messages remain in the queue. Not only does this consume large amounts of storage space, but it also consumes significant processing resources

as the email delivery server will repeatedly try to send the messages until it no longer receives a failure message.

[0006] One prior art approach to alleviating this problem is to implement a secondary queue at the email delivery server, which is sometimes referred to as a spillover or fallback queue. When a delivery failure is received for a particular email message stored in the delivery server's primary queue, the email message is then moved to the secondary queue. The email delivery server may then attempt to send messages stored in the secondary queue at a lower sending rate than the primary queue. This helps conserve system resources in that the email delivery server is not spending as much time trying to re-send the failed messages, and it does not have to access the primary queue as often. Two examples of email server systems which use secondary queues are the Sendmail High Volume Mail Solution (HVMS), and Cisco System's E-mail Manager.

[0007] Despite the advantages of such systems, additional flexibility for managing primary and secondary queues of email delivery servers may be desirable in certain applications.

Summary of the Invention

[0008] In view of the foregoing background, it is therefore an object of the present invention to provide a communications system which provides enhanced email queue management features and related methods.

[0009] This and other objects, features, and advantages in accordance with the present invention are provided by a communications system which may include at least one destination server for hosting a plurality

of electronic mail (email) message boxes, and a plurality of communications devices for generating email messages each associated with a respective message box. The system may further include a delivery server including a plurality of queues and a controller.

[0010] More particularly, the controller may be for storing the email messages generated by the communications devices in a first queue, and attempting to send the stored email messages to the at least one destination server at a first sending rate. The controller may also move email messages stored in the first queue to a second queue based upon a delivery failure. The controller may then attempt to send email messages stored in the second queue to the at least one destination server at a second sending rate less than the first sending rate. The controller may also advantageously move email messages from the second queue to the first queue having a common characteristic with a successfully delivered email message.

[0011] By way of example, the delivery failures may be based upon a failure to deliver email messages to respective message boxes, and the common characteristic may thus be a common message box. Moreover, the at least one destination server may be a plurality of destination servers. Accordingly, the delivery failures may be based upon a failure to deliver email messages to respective destination servers, and the common characteristic may be that the email messages have respective message boxes hosted by a common destination server. Thus, the controller advantageously moves email messages to the first queue for quicker delivery to the appropriate destination server once it has been

determined that the destination server or message box is able to receive email messages.

[0012] Furthermore, the controller may store directly in the second queue email messages generated by the communications devices which share the common characteristic with an email message already stored in the second queue. Thus, for example, if a new message is received from a communications device that has the same destination server and/or message box associated therewith as a message already moved to the second queue, then the message may be stored directly in the second queue. That is, since it is already known that attempts to send email messages to the destination server and/or message box in question have previously failed, there is no need to fill the first queue with a new message whose delivery will most likely fail for the same reason.

[0013] The second queue may also be a plurality thereof arranged in a hierarchy each having a respective storage interval associated therewith. Further, the storage intervals may successively increase from a highest queue in the hierarchy to a lowest queue. The controller may thus move email messages to one of the queues in the hierarchy (e.g., the highest queue) based upon a delivery failure. Also, the controller may move email messages stored in a higher queue in the hierarchy to a next lower queue in the hierarchy after being stored in the higher queue for the respective storage interval thereof. Moreover, the controller may attempt to send messages from each of the queues in the hierarchy at successively decreasing sending rates from the highest queue to the lowest queue. Further, the controller may discard

messages from the lowest queue in the hierarchy after being stored therein for the storage interval thereof.

[0014] By way of example, one or more of the plurality of communications devices may be a wireless communications device. Also, the communications system may further include a wide area network (WAN), such as the Internet, connecting the at least one destination server and the delivery server.

[0015] An email communications method aspect of the invention may include hosting a plurality of email message boxes on at least one destination server, and generating email messages each associated with a respective message box. The method may further include storing the email messages in a first queue, and attempting to send the stored email messages to the at least one destination server at a first sending rate. Additionally, email messages stored in the first queue may be moved to a second queue based upon a delivery failure thereof. The method may also include attempting to send email messages stored in the second queue to the at least one destination server at a second sending rate less than the first sending rate, and moving email messages from the second queue to the first queue having a common characteristic with a successfully delivered email message.

[0016] Other advantageous aspects of the invention relate to a delivery server, such as the one described briefly above, and a related computer-readable medium.

Brief Description of the Drawings

[0017] FIG. 1 is a schematic block diagram of a communications system in accordance with the present invention.

[0018] FIG. 2 is a schematic block diagram of an alternate embodiment of the communications system of FIG. 1.

[0019] FIG. 3 is flow diagram illustrating an email communications method in accordance with the present invention.

[0020] FIG. 4 is flow diagram illustrating an alternate embodiment of the email communications method of FIG. 3.

Detailed Description of the Preferred Embodiments

[0021] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout, and prime notation is used to indicate similar elements in alternate embodiments.

[0022] Referring initially to FIG. 1, a communications system **20** in accordance with the present invention illustratively includes a destination server **21** for hosting a plurality of email message boxes (MB) **22a-22n**. While only a single destination server **21** is shown in the illustrated example for clarity of illustration, it will be appreciated by those skilled in the art that numerous destination servers may be used, as will be discussed further below. Further, the system **20** also illustratively includes a plurality of

communications devices **23-25** for generating email messages each associated with a respective one of the message boxes **22a-22n**. By way of example, the communications devices **23-25** may be laptop computers, personal data assistants (PDAs), and desktop personal computers (PC), as illustratively shown. Other suitable devices for generating emails may also be used, as will be appreciated by those skilled in the art.

[0023] A delivery server **26** receives the emails from the communications devices **23-25** and sends them to the destination server **21**. In the illustrated example, the delivery server **26** and destination server **21** communicate via a wide area network (WAN) **27**, such as the Internet, for example. The communications devices **23-25** may be connected with the delivery server **26** in a local area network (LAN), for example, including a wireless LAN (WLAN) in some embodiments, as will be appreciated by those skilled in the art.

[0024] In particular, the delivery server **26** illustratively includes a controller **30**, a first (or primary) queue **31**, and a second queue **32**. The controller **30** stores the email messages generated by the communications devices **23-25** in the first queue **31**. The controller **30** then attempts to send the email messages stored in the first queue **31** to the destination server **21** at a first sending rate. Typically, messages will be sent from the first queue **31** at a relatively fast rate, such as every few minutes or less. The controller **30** may be implemented as a software module which runs on the delivery server **26**, and the queues **31, 32** may be implemented as database modules, for example.

[0025] Once received by the destination server **21**, the destination server delivers the email messages to their respective message boxes **22a-22n**. As will be appreciated by those skilled in the art, an address is associated with an email message when it is generated. The address identifies the message box **22** for which the message is intended, as well as the destination server **21** hosting the message box. Depending upon a given implementation, the destination server **21** may return a confirmation indication to the delivery server **26** to indicate that an email message has been successfully delivered to the appropriate mailbox **22**.

[0026] Yet, as discussed above, it is not uncommon for email message delivery to fail for a variety of different reasons. By way of example, message boxes **22a-22n** hosted on a corporate or Internet service provider's (ISP's) server will typically be allotted a limited amount of storage space. If a user does not empty his respective message box **22**, he will eventually exceed his allotted storage space, and the delivery server **21** will then stop storing messages for that user until space is once again made available. If a message box **22** is full and a new message arrives at the destination server **21** for this message box, the destination server will return a failure message to the delivery server **26**. By way of example, a failure message resulting from a full mailbox may take the form of a fatal error data source name (DSN) code, as will be appreciated by those skilled in the art.

[0027] Another reason for a delivery failure may be that the destination server **21** is down or otherwise unavailable. In this case, a server or other routing device within the WAN **27** may generate a failure message

for the delivery server **26** letting it know that the destination server **21** is unavailable. For example, the delivery server **26** may receive a temporary failure DSN code in such an event.

[0028] When the controller **30** receives one of the above types of delivery failure messages (or others) for a given email message, the controller then advantageously moves the message to the second queue **32**. This promotes system resource savings in several ways. First, the controller attempts to send email messages stored in the second queue **32** to the destination server **21** at a second sending rate less than the first sending rate. Thus, the controller **30** does not have to devote as much time to re-sending these messages as it otherwise would if they were still in the first queue **31**. Moreover, the second queue may be stored within a different directory or location of the delivery server **26**. Thus, the number of operations that require access to the first queue **31** at any given time is reduced, which helps reduce bottlenecks, as will be appreciated by those skilled in the art.

[0029] In accordance with the invention, the controller **30** may also advantageously move email messages from the second queue **32** to the first queue **31** having a common characteristic with a successfully delivered email message. More particularly, if an email message had been moved to the second queue **32** because its respective message box **22** was full, the successful delivery of another email message to that same message box would indicate to the controller **30** that the message box was again able to receive messages. Accordingly, the controller **30** would move the email message from the second queue **32** to the first queue **31**

so that it would be delivered more quickly to the given message box **22**.

[0030] Similarly, if the delivery failure is a result of a destination server **21** failure, then the controller **30** may then move email messages which were stored in the second queue **32** because of the destination server's unavailability to the first queue **31** once it is determined that the destination server is once again available. This embodiment is particularly advantageous where there are numerous destination servers **41'**, **51'** for which delivery failure messages may be received, as shown in FIG. 2. In this exemplary embodiment, the destination servers **41'**, **51'** and their respective messages boxes **42a'-42n'**, **52a'-52n'** are similar to the destination server **21** and messages boxes **22a-22n** noted above.

[0031] Moreover, in the present embodiment the delivery server **26'** communicates with wireless communications devices **35'**, **36'** via a wireless communications network **37'**. By way of example, the wireless communications network **37'** may be a cellular network, and the wireless communications devices **35'**, **36'** may be cellular-based email devices such as Blackberry devices or email ready cellular telephones, as shown.

[0032] To provide still further efficiencies, the single second queue **32** described above has been replaced in the present embodiment with a plurality of queues **32a'-32c'** arranged in a hierarchy (HQs), as shown. Here, the queue **32a'** is the highest queue in the hierarchy, the queue **32b'** is the intermediate queue, and the queue **32c'** is the lowest queue. Each queue **32a'-32c'** has a respective storage interval associated

therewith, and these intervals successively increase from the highest queue **32a'** to the lowest queue **32c'**.

[0033] Thus, when an email message has been stored in a given one of the queues **32a'-32c'** for the respective storage interval thereof, the controller **30'** moves the email message to the next lower queue in the hierarchy. This helps further relieve congestion over the use of a single second queue, as email messages are then distributed over multiple queues instead of all collecting in one. Of course, the number of queues used in a given hierarchical implementation will vary depending upon the email message volume being handled and other considerations, as will be appreciated by those skilled in the art.

[0034] One exemplary embodiment would be to include seven second queues which respectfully store email messages up to intervals of one hour, two hours, four hours, eight hours, twelve hours, twenty-four hours, and forty-eight hours after they are received by the controller **30'**. Once an email message has remained in the lowest queue in the hierarchy for the storage interval thereof, the controller **30'** may discard the message, for example. Of course, other actions could be taken, such as notifying the user who generated the email message of its failure to be delivered, etc., as will be appreciated by those skilled in the art.

[0035] The controller **30'** may also attempt to send messages from each of the queues **32a'-32c'** at successively decreasing sending rates from the highest queue **32a'** to the lowest queue **32c'**. Accordingly, the email messages do not have to be processed as often once they are moved to a next lower queue in the

hierarch, as discussed above. Various sending rates may be used based upon the given implementation.

[0036] In accordance with another particularly advantageous feature of the invention, the controller **30'** may store directly in any one of the queues **32a'-32c'** email messages generated by the communications devices **35'**, **36'**. This would be done when such messages share a common destination server **41'**, **51'** and/or message box **42'**, **52'** with an email message already stored in one of the queues **32a'-32c'**, where such destination server or message box was the reason for the unsuccessful delivery of the stored message.

[0037] Thus, for example, if a new message is received from the communications device **35'** that has the same destination server and/or message box associated therewith as a message already in one of the queues **32a-32b'**, then the message is stored directly in one of these queues. This could be the highest queue **32a'**, or the same queue in which the email message with the common characteristic is already stored, for example.

[0038] It should be noted that rather than restoring a message to the first queue **31'** after a successful delivery of another email message having a common characteristic therewith, as described above, the message could instead be moved to another in the hierarchy (or other queue), if desired. Moreover, the controller **30'** could check multiple common characteristics (e.g., server failure, message box failure, etc.) in determining whether to move email messages to the first queue **31'**. Thus, for example, if it was determined that a given delivery server was once again available, the controller **30'** may move all email

messages stored in the queues **32a'-32c'** to the first queue **31'**, except those for which delivery failed because of a message box delivery failure. Also, the successful delivery of a message need not be from the first queue **31'**, but it could be from any of the queues **32a'-32c'** as well.

[0039] An email communications method aspect of the invention will now be described with reference to FIG. 3. Beginning at Block **60**, email messages are generated by the communications devices **23-25** (Block **61**), each of which is associated with a respective message box **22a-22n**. The email messages are stored in the first queue **31** (FQ) and an attempt is made to the destination server **21** at a first sending rate, at Block **62**. Additionally, email messages stored in the first queue **31** are moved to the second queue **32** (SQ) based upon a delivery failure, at Blocks **63-64**.

[0040] The method further illustratively includes attempting to send email messages stored in the second queue **32** to the destination server **21** at a second sending rate less than the first sending rate, at Block **65**. Further, email messages are moved from the second queue **32** to the first queue **31** having a common characteristic with a successfully delivered (Block **66**) email message, at Block **67**, as discussed above, thus concluding the illustrated method (Block **68**).

[0041] Turning additionally to FIG. 4, further method aspects of the invention which may be performed using the hierarchical second queue structure illustrated in FIG. 2 are now described. As noted above, the controller **30'** may determine that a newly received email message has a common characteristic(s) with another message already stored in one of the

hierarchical queues **32a'-32c'**, at Block **70'**. If this is the case, the controller **30'** stores the email message in the highest queue **32a'** in the hierarchy, for example, at Block **71'**.

[0042] If no successful delivery of another email message sharing a common characteristic occurs (Block **66'**), the controller **30'** attempts to send the messages from the queue **32a'** during the storage interval thereof, at Blocks **72'-73'**. The email messages are successively moved down the hierarchy of queues **32a'-32c'** and the foregoing steps are repeated, until the lowest queue **32c'** is reached and the storage interval thereof expires, at Blocks **74'-75'**, at which point the email messages are discarded (Block **76'**). Of course, if at any point before discarding a successful delivery occurs, the stored message(s) sharing the common characteristic is moved to the first queue **31'** and sent (Block **77'**) as described above.

[0043] Other advantageous aspects of the invention relate to a delivery server **26**, such as the one described briefly above, and a related computer-readable medium for performing the steps described above with reference to FIGS. 3 and 4.

[0044] Many modifications and other embodiments of the invention will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is understood that the invention is not to be limited to the specific embodiments disclosed, and that modifications and embodiments are intended to be included within the scope of the appended claims.